

Critical species of Odonata in Europe

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ABSTRACT

The status of the odonate fauna of Europe is fairly well known, but the current IUCN Red List presents only six species out of ca 130, two of which are actually out of danger today. In this paper we propose a tentative list of 22 possibly declining or threatened species in the region. For the majority, reliable data of population size and possible decline is still lacking. Also 17 endemic species are listed, most occurring in the two centres of endemism in the area: the south-eastern (mountains and islands) and the western Mediterranean. These species should receive extra attention in future updates of the world Red List due to their limited distribution. The extreme variation in biomes and the human exploitation of habitats make conservation planning complicated in Europe. Within the EU, the FFH directive is a working tool aiding conservation. However, the species included do not fully correspond to those on the current Red List, nor to those discussed in this paper. We believe that future conservation efforts should focus on the most valuable and threatened habitats in each sub-region. Active conservation measures could be implemented on a European scale, provided that research will establish a solid ground for such measures.

REGIONAL DEFINITION

In this report the boundaries of Europe are slightly reduced compared to the usual geographical definition. As the fauna of the Ural Mountains is special but also in many aspects Siberian, we exclude the eastern areas of European Russia and Kazakhstan, partly also because of little knowledge of the status of the species present. Hence we use the 40th meridian as a rough limit to the east. This means that Europe in this paper includes everything west of a line from the Kola Peninsula south to the eastern border of Ukraine, including that country but excluding the countries south and south-east of it. All the islands of the Mediterranean except Cyprus are included, as is the Thracian part of Turkey. In the Atlantic, the Canary Islands, Madeira and the Azores are excluded, but Iceland and the Faeroe Islands

Table 1. European Odonata species on the 2003 Red List (IUCN 2003) assessed using the 1994 categories and their distribution and status. CR: critically endangered; LR: lower risk; VU: vulnerable.

Species	Red List category	Distribution	Status
<i>Coenagrion hylas freyi</i> Bilek, 1954			
	CR	Germany, Austria, very restricted area in the Alps	Very few populations, German population extinct
<i>mercuriale</i> (Charpentier, 1840)			
	VU	Mediterranean, W and C European countries	Locally common, e.g. in NW Spain, but many populations still declining
<i>Aeshna viridis</i> Eversmann, 1836			
	LR	Populations in N, C and E Europe, also Siberia	In some areas fairly abundant. Not threatened, except in the areas of its range limit
<i>Gomphus graslinii</i> Rambur, 1842			
	VU	Iberian peninsula, France	Few populations on the Iberian peninsula. Biology almost unknown
<i>Macromia splendens</i> (Pictet, 1843)			
	VU	Iberian peninsula, France	Very restricted distribution range. A rare and threatened species, although locally common in NW Spain and SE France
<i>Oxygastra curtisii</i> (Dale, 1834)			
	VU	Western countries, also Morocco	Stable populations in France and Spain. Not threatened

included. Although the fauna of northern Africa is predominantly West Palaearctic in origin, the status of the species in the countries of northern Africa is not evaluated in this report (but see Jödicke et al. 2004).

Biomes in Europe go from arctic tundra in the extreme north changing through coniferous boreal forest and temperate deciduous forest to the Mediterranean macchia and the westernmost part of the Eurasian steppe in the south-east. Most of these biomes, apart from the tundra and parts of the boreal forest, are severely affected by human activities, and the natural habitats are in many countries reduced to a fraction of their original size. In densely populated areas there are few natural habitats left, but secondary habitats suitable for Odonata, e.g. canals, waterbodies in gravel, sand and clay pits, ponds, dams, and constructed wetlands, are numerous.

STATE OF THE ART

Studies on taxonomy, ecology and biodiversity

Europe has a long tradition of work on Odonata (e.g. Swammerdam 1737, 1738; Réaumur 1748; Charpentier 1840; Wesenberg-Lund 1913; Portmann 1921; Münchberg 1932). The fauna of Europe is fairly well known with most of the taxonomy completed during the 19th century, although a few new species have been described since (e.g. *Somatochlora borisi*, Marinov 2001). The distribution patterns of some species are currently changing due to global warming (e.g. Ott 1996, 2001). Ecological, biological and taxonomical information is available from several publications and books (cf. Schiemenz 1953; Robert 1958, 1959; Corbet et al. 1960; Corbet 1962, 1999; Buchwald 1992; Miller 1995; d'Aguilar & Dommanget 1998; Sternberg & Buchwald 1999, 2000). European monographs exist for Lestidae (Jödicke 1997), Platycnemididae (Martens 1996) and Gomphidae (Suhling & Müller 1996). A monograph on the European Corduliidae is in preparation by H. Wildermuth. Publications in referred journals and theses on certain species, communities and topics are abundant and cannot be quoted here in detail. However, there are only a few studies that deal with biodiversity patterns (but see Sahlén & Ekestubbe 2001) or the effects of climate change on species composition (cf. Ott 2001).

Identification guides

Identification is in many cases straightforward as keys for adults are available on the national, regional and European level (e.g. Schmidt 1929; Conci & Nielsen 1956; Hammond 1977, 1983; d'Aguilar et al. 1986; Bellmann 1987; Askew 1988; Norling & Sahlén 1997; d'Aguilar & Dommanget 1998; Lehmann & Nüß 1998; Bos & Wasscher 2002). Larvae and exuviae are also treated in many areas and larval/exuvial identification guides include Carchini (1983a, 1983b), Conesa García (1985), Bellmann (1987), Müller (1990), Heidemann & Seidenbusch (1993, 2002), Norling & Sahlén (1997) and Gerken & Sternberg (1999).

Faunal lists

Faunal lists are available in most countries, and some lists cover the entire area (e.g. Askew 1988; d'Aguilar & Dommanget 1998). Additionally, there are also several country and state checklists, often in the form of books, which also include distribution maps (e.g. Mendel 1992; Dommanget 1994; Merritt et al. 1996; Sahlén 1996; Kuhn & Burbach 1998; Nielsen 1998; Sternberg & Buchwald 1999, 2000; NVL 2002). These books have greatly influenced public awareness on Odonata and stimulated many people to start studying these insects. However, particularly in the south-east, the fauna composition is not fully known, although the state of knowledge has improved considerably in recent decades. Recent odonate fauna lists exist for Slovenia (Kotarac 1997), Bulgaria (Marinov 2000), and Greece (Lopau & Wendler 1995; Lopau 1999, 2000).

CRITICAL SPECIES

Notes on some species previously listed by IUCN

On the IUCN Red List of threatened species (IUCN 2003) six European species out of the regional fauna of ca 130 species are listed (Table 1), all assessed using the 1994 Red List criteria. One species is assigned to 'critically endangered', four to 'vulnerable' and one to 'lower risk'. In Table 1 we give comments on the current status of the red-listed species, two of which appear to be of less concern today. In the case of *Aeshna viridis* the original assessment was presumably based on insufficient data. In the case of *Oxygastra curtisii* the species has established large and most probably safe populations within its main range, i.e. on the Iberian Peninsula and in France. It has also recovered in Germany.

Species to be considered

In Table 2 we present an overview of threatened species in Europe. It is mostly based on expert judgement and data on distribution and trends in the different countries. The qualities of these data are varied; in most north-western European countries good data exists, but in many areas in the south and east the information is scarce. We propose a tentative list of 22 possibly declining or threatened species in Europe (Table 2), including those on the current world Red List, which are under threat. For some, the decline and threats are clear to us, but for the majority we still lack reliable data of populations and possible decline. All these species need to be thoroughly evaluated before assigning them Red List categories. As the systematic status of some subspecies and/or colour forms is still under debate, we only list species with the exception of *Coenagrion hylas freyi* since it is already on the world Red List as a threatened subspecies.

Endemic species

A number of endemic species occurs in different parts of Europe, and even more endemic subspecies. In this report we only discuss endemism on the species level and follow the nomenclature used by d'Aguilar & Dommange (1998) as to which (former) subspecies are given species status, except for *Pyrrhosoma elisabethae* (V. Kalkman & W. Lopau in prep.). A monographic work on the distribution and identification of European *Cordulegaster* was published by Boudot (2001). *Ischnura genei* might be only a subspecies to *I. elegans* (Vander Linden, 1820) (Carchini et al. 1994). The status of *Aeshna osiliensis* is still not definitely resolved (cf. Peters 1987) although recently this taxon is usually considered a distinct species. The main area of endemism in Europe is in the south-east, with mountains and islands as typical habitats. Another centre of endemism is the western Mediterranean. However, most species endemic to this area also occur in the Maghreb (North Africa). In Table 3 we list 17 endemic species, of which we believe most should receive extra attention due to their limited distribution. Some of them are already listed in Tables 1 and 2.

Species sensitive in a longer time-perspective

It is always difficult to speculate on which human induced environmental changes will occur and what effects they will have on the fauna, but we feel it is relatively safe to highlight the water vegetation-Odonata connection that exists in many species (cf. Buchwald 1990, 1992, 1994). Such habitat-specific species are naturally more sensitive than others that can live in a range of different habitats. A typical example is *Aeshna subarctica elisabethae* Djakonov, 1922, a species strictly related to *Sphagnum* habitats. In many areas of Europe, the number of such habitats has

Table 2. Species of Odonata with declining populations or restricted distribution found in Europe. Distribution, status and cause of decline/threats (if known). Systematics follows d'Aguilar & Dommange 1998, except for *Ceriagrion georgifreyi* (Schneider 1986), *Pyrrhosoma elisabethae* (V. Kalkman & W. Lopau in prep.), *Aeshna osiliensis* (Peters 1987) and *Cordulegaster* (Boudot 2001).

Family/species	Distribution	Status	Cause of decline/threat
Lestidae			
<i>Lestes macrostigma</i> (Eversmann, 1836)			
	Mainly Mediterranean, patchy and very local in some areas. Also Siberia and Central Asia	Possibly declining	Unknown
Coenagrionidae			
<i>Ceriagrion georgifreyi</i> Schmidt, 1953			
	Eastern Mediterranean	Restricted range	Habitat disturbance (?)

Family/species	Distribution	Status	Cause of decline/threat
Coenagrionidae (continued)			
<i>Coenagrion armatum</i> (Charpentier, 1840)	Northern and eastern countries, westward only rare populations in C Europe, formerly up to UK. Also Siberia	Still stable populations in the Nordic countries and probably the Baltic states, but extinct or sharply declining in W and C Europe	Habitat disturbance/habitat change due to acidification, eutrophication and desiccation
<i>hylas freyi</i> (Bilek, 1954)	Germany, Austria, very restricted area in the Alps	Very few populations, German population extinct	Habitat disturbance
<i>intermedium</i> Lohmann, 1990	Crete	Seems to be still common on Crete, but has very restricted range	Habitats under severe threat from development and water extraction
<i>mercuriale</i> (Charpentier, 1840)	Mediterranean, western and Central European countries. Also N Africa	Decreasing populations	Drying out of small streams due to water extraction, intensification of agriculture
<i>ornatum</i> (Selys, 1850)	C, S and E Europe, also Turkey.	Declining, at least in parts of C Europe	Habitat change and habitat loss
<i>Nehalennia speciosa</i> (Charpentier, 1840)	Patchy distribution from W Germany (formerly Belgium) and N Italy to Nordic and eastern countries. Also Siberia to Japan.	Declining, probably in the whole area, sharply everywhere to the west and south of Belarus and the Baltic States; extinct in many areas	Habitat disturbance/habitat change
<i>Pyrhosoma elisabethae</i> Schmidt, 1948	Greece, Albania (Small range)	Only seven records known	Unknown
Aeshnidae			
<i>Aeshna crenata</i> Hagen, 1856	Finland, N Russia, Latvia, Lithuania and Belarus. Also Siberia	Rare, few known populations, limited distribution range or patchy distribution	Habitat disturbance/change
<i>osiliensis</i> Mierzejewski, 1913	Estonia, Finland and Sweden	No observed decline but the only endemic species of N Europe, also with an unusual biology i. e. breeds in brackish waters	Unknown
<i>Boyeria cretensis</i> Peters, 1991	Crete	Very restricted range and only a few populations	Unknown

Family/species	Distribution	Status	Cause of decline/threat
Gomphidae			
<i>Gomphus graslinii</i> Rambur, 1842	Iberian Peninsula, France	Restricted range	Unknown
<i>Onychogomphus costae</i> (Selys, 1885)	Spain, Mediterranean parts of Morocco, Algeria, Tunisia and a few Saharan records	Few populations in Spain and also a restricted world distribution	Unknown
Cordulegastridae			
<i>Cordulegaster helladica</i> (Lohmann, 1993)	Greece	Limited distribution range	Unknown
<i>heros</i> Theischinger, 1979	Slovakia and Austria to Greece	Limited distribution range	Unknown
<i>trinacriae</i> Waterston, 1976	Italy south of Rome, including Sicily	Probably a restricted distri- bution range	Unknown
Corduliidae			
<i>Macromia splendens</i> (Pictet, 1834)	SW France, Spain and Portugal	Only present in a few river systems, common only at a few localities	Habitat disturbance/ habitat change?
<i>Somatochlora borisi</i> Marinov, 2001	Bulgaria and Greece	Restricted to the Rhodopes Mts and Thracia	Limited range
<i>sahlbergi</i> Trybom, 1889	Northernmost parts of Norway, Sweden, Fin- land and Russia. Holarctic.	Few known populations in remote areas	No observed decline but data is missing on how common or rare this species is
Libellulidae			
<i>Leucorrhinia albifrons</i> (Burmeister, 1839)	S Fennoscandia, C Europe and eastwards to Siberia	Decreasing populations in a large part of C Europe although common in many areas in the north and east	Habitat loss due to eutrophication
<i>caudalis</i> (Charpentier, 1840)	S Fennoscandia, C Europe and eastwards. Also W Siberia	In many areas patchily dis- tributed. Sharp decline in western areas of European range	Habitat loss due to eutrophication and also acidification

rapidly decreased. Another example is *Sympecma paedisca* which is associated with shallow waters with *Phragmites australis*, *Typha* spp. and *Carex* spp. It is rare within the western parts of its limited European range, but eastwards it becomes more numerous, extending the range towards Japan. The species shows a sharp downward trend in some parts of Central Europe. Only a few good relict populations are left in the Netherlands and Germany but numerous strong populations occur already in Poland. Also *Leucorrhinia pectoralis* falls under this criterion. It is a species of complex stages of vegetation succession in mesotrophic to eumesotrophic waters. A sharp decline is recognisable in the westernmost parts of its range, and there its distribution is very patchy. *Sympetrum depressiusculum* (Selys, 1841) is another species declining in the western areas of Europe. Like all members of the genus *Sympetrum* it is opportunistic, appearing in specific anthropogenic habitats (in W Europe winter dry fish ponds and rice fields). The major cause of decline in these habitats is the change in management practices.

CONSERVATION PRIORITIES

The extreme variation in biomes in Europe in combination with the human exploitation of many habitats makes conservation planning a complicated matter. Some species, which have declined, e.g. in western, Central and parts of eastern Europe, may still abound in other areas. Species are generally more sensitive to disturbance near their range limits than in the central areas of their distribution. Hence it is an impossible task to propose generalised conservation measures for all European species. Each region must look at the species pool present and take appropriate corrective measures.

Generally speaking, conservation efforts should be focused on the most valuable and threatened habitats in each sub-region. Efforts should include both passive and active (e.g. reintroduction, see below) measures. Rare and species-rich habitats housing the regionally threatened species should be preserved in a state close to natural, must be protected against stocking with fish and secured against excess influx of nutrients (e.g. Bernard et al. 2002). For running waters, buffer zones should be maintained in forested areas to prevent nutrient influx, but in the open landscape more active measures may be needed, e.g. mowing of water vegetation (including bank vegetation) and possibly also periodical cleaning of some sections of the streams. In urbanised surroundings more active methods are needed. Naturally, it would be necessary to use legal measures to ensure such protection.

Two examples are given here: In Central and eastern Europe, *Sphagnum* bogs and small forest lakes bounded by *Sphagnum* are in need of conservation measures. In these habitats many threatened or potentially threatened (on a European or local scale) species reproduce, e.g. *Nehalennia speciosa*, *Coenagrion johanssoni* (Wallengren, 1894), *Aeshna caerulea* (Ström, 1783), *A. crenata*, *A. subarctica elisabethae*, *Somatochlora arctica* (Zetterstedt, 1840) and *S. alpestris* (Selys, 1840). In northern Europe there are, by contrast, hundreds of thousands of such lakes, tarns and bog pools in northern Sweden and Finland alone. Most of the species above, except *N. speciosa* and *A. crenata*, are common in this area.

Several of the species listed in this paper co-occur in the Mediterranean. Here, the habitats of all species are endangered particularly due to habitat destruction caused by water extraction for human use and by increasing periods of drought. Particularly small streams and rivers suffer from these factors. Hence, a more sustainable use of the water resources, with respect to freshwater species, would be an appropriate measure to protect odonate species and communities. Several of the listed species occur in Greece, and at least the status of the island populations of *Boyeria cretensis* and *Coenagrion intermedium* seems to be critical. For these species, as well as for *Somatochlora borisi* (also Bulgaria) and *Cordulegaster helladica*, special action programmes should be implemented.

Table 3. Endemic species in Europe. No subspecies except *Coenagrion hylas freyi* are considered.

Family/species	Area	State of knowledge
<i>Calopteryx taurica</i> Selys, 1853	Crimean peninsula	Little data available
<i>Coenagrion hylas freyi</i> (Bilek, 1954)	Germany, Austria (small range)	Good data available
<i>intermedium</i> Lohmann, 1990	Crete (small range)	Little data available
<i>Pyrrhosoma elisabethae</i> Schmidt, 1948	Greece, Albania (small range)	Very little data available
<i>Ischnura genei</i> (Rambur, 1842)	Sicily, Sardinia, Corsica, Malta and islands at the Italian west coast	Some data available
<i>Platycnemis acutipennis</i> Selys, 1841	W Europe	Good data available
<i>latipes</i> Rambur, 1842	W Europe	Good data available
<i>Gomphus graslinii</i> Rambur, 1842	Restricted to few river systems in SW France, Spain and Portugal	Good data available, except of some regions of Spain
<i>Gomphus pulchellus</i> Selys, 1840	W Europe east to the Elbe River, range extending	Good data available, not threatened
<i>Aeshna osiliensis</i> Mierzejewski, 1913	C and N Baltic Sea area	Good data available
<i>Boyeria cretensis</i> Peters, 1991	Highly endemic with only few populations on Crete	Little data available
<i>Cordulegaster bidentata</i> Selys, 1843	E Spain through C and S Europe to Ukraine	Good data available, not threatened
<i>helladica</i> (Lohmann, 1993)	Restricted to parts of Greece	Little data available
<i>heros</i> Theischinger, 1979	Restricted to the area from Slovakia and Austria southward to Greece	Some data available
<i>trinacriae</i> Waterston, 1976	Italy south of Rome, including Sicily	Little data available
<i>Macromia splendens</i> (Pictet, 1834)	Restricted to few river systems in SW France, Spain and Portugal	Good data available in France and NW Spain
<i>Somatochlora borisi</i> Marinov, 2001	Restricted to the Rhodopes Mts in Bulgaria and Thracia	Some data available

CRITICAL SITES AND RESEARCH PRIORITIES

A thorough analysis of odonate distribution and habitat preferences should be a priority for research and conservation in Europe. Such an analysis would highlight a set of 'hot spots' ('odonate centres') in the region. These centres should then be evaluated and special conservation programmes for the most valuable localities could be established. The first steps to assess Prime Dragonfly Areas in Europe were undertaken by Ketelaar & Kotarac (2002). The Prime Dragonfly Areas project aims to identify an initial list of the most important areas for odonate conservation concern in Europe. It will result in a publication comparable to the recent work on butterflies (Van Swaay & Warren 2003).

It is also important to concentrate research efforts on the more "unknown" species on islands or in remote mountain areas. Until we know more about their ecology and status no conservation measures can be proposed. Other suggested research priorities are metapopulations and island populations (including molecular genetical analyses) to validate population status, research on effects of climate change and studies on eastern species which have recovered in areas of Central Europe west of Poland recently, e.g. *Gomphus flavipes* and *Ophiogomphus cecilia*.

CURRENT ACTIVITIES

The Fauna-Flora-Habitat (FFH) directive of the European Union

The FFH directive of the European Union protects certain species (cf. Table 4) as well as certain habitats (92/43/EEG of 21 May 1992), which are also important to odonate species. With the ten new members of the EU, two additional species are listed under the directive, *Coenagrion ornatum* in Appendix II and *Cordulegaster heros* in Appendix II and IV (European Commission 2002). The FFH directive is a comparatively powerful instrument to protect populations and habitats because the European Commission is able to apply sanctions to countries and states failing to fulfil the aims of the directive. The 14 odonate species considered by the directive are listed in two appendices. Appendix II contains species that have to be included in a network of protected habitats (listed in Appendix I). For species in Appendix IV measures have to be taken in order to ensure that the populations in the respective countries will persist. All countries of the EU have to report on the health of the populations of all species existing in their countries at six-year intervals. However, the directive does not cover all species currently included neither on the World Red List, nor those listed by us in Table 2. It would probably be useful to unify these lists. Action is recommended.

Species protection under national law

To date, several European countries and states have set up directives for the protection of Odonata, e.g. France, Germany, the Netherlands, Poland and Spain. National regulations differ and are too varied for us to define. We can, however, see two opposite ongoing trends: in some countries (e. g. Germany and Spain), all species are protected while in other countries (e.g. Norway and Sweden) no species

are protected. Sweden has allowed the collection of voucher specimens of the FHH species with regard to the inadequate knowledge of their national status and distribution patterns. Both these methods (protect everything vs protect nothing) work well in the respective countries, but habitat protection is naturally a better tool than protection of individual species.

In some countries, action programmes aiming at the protection of a few target species are being implemented. In the Netherlands, such a species action programme has recently started for *Aeshna viridis* (De Jong & Verbeek 2001) and is in a final stage for *Coenagrion armatum*, *Sympecma paedisca*, *Somatochlora arctica* and *Leucorrhinia pectoralis* (Ketelaar et al. 2001; Wallis de Vries & Rossenaar 2003; Ketelaar 2004). The purpose of these action programmes is the sustainable recovery and revitalisation of populations by conservation measures, education and legislation. For *Aeshna viridis*, a full-time co-ordinator has been appointed and a website <www.groeneglazenmaker.nl> is the central point of information. In Great Britain, a full-time conservation officer of the British Dragonfly Society has been appointed to stimulate and initiate conservation measures for the Odonata. In Poland and the Baltic States, a project '*Nehalennia speciosa* – present state, biology, threats and conservation' is in progress. Several distribution atlases are also in production, e.g. the atlas of distribution of Odonata in Poland, and a mapping project in the Czech Republic. Needless to say, mapping projects are essential before proposing any conservation measures.

In the future, active conservation measures could be implemented on a European scale, provided that current and future research will establish a solid ground for these measures. One example is the reintroduction of certain declining species to restored former habitats or to new sites deemed suitable to sustain the species. Some pilot projects are already prepared or running, e. g. in Poland, where a small programme has just been prepared to reintroduce *Nehalennia speciosa* into areas where it formerly occurred.

Table 4. Species considered by the Fauna-Flora-Habitat directive of the EU. List valid prior to Union expansion, May 2004, see text for new species.

Species	Appendix II	Appendix IV
<i>Sympecma paedisca</i> (Brauer, 1877)	○	●
<i>Coenagrion mercuriale</i> (Charpentier, 1840)	●	●
<i>hylas</i> (Trybom, 1889)	●	●
<i>Aeshna viridis</i> Eversmann, 1836	○	●
<i>Gomphus flavipes</i> (Charpentier, 1825)	○	●
<i>graslinii</i> Rambur, 1842	●	●
<i>Lindenia tetraphylla</i> (Vander Linden, 1825)	●	●
<i>Ophiogomphus cecilia</i> (Geoffroy in Fourcroy, 1785)	●	●
<i>Cordulegaster trinacriae</i> Waterston, 1976	●	●
<i>Macromia splendens</i> (Pictet, 1843)	●	●
<i>Oxygastra curtisii</i> (Dale, 1834)	●	●
<i>Leucorrhinia albifrons</i> (Burmeister, 1839)	○	●
<i>caudalis</i> (Charpentier, 1825)	○	●
<i>pectoralis</i> (Charpentier, 1825)	●	●

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